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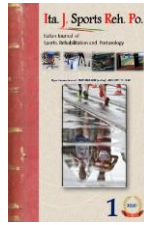
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# Ita. J. Sports Reh. Po.

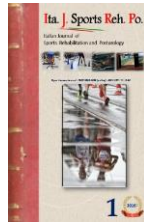
Italian Journal of  
Sports Rehabilitation and Posturology

## Diagonals Part four : Stroke 2 - Transfers in bed and the chain rules.

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## Abstract

*An Individuals diagonals tend to be severely affected following a stroke. Therefore training needs to focus on restoring the diagonals and if possible the homo- lateral structure on the affected side. Maintaining overall movement in bed is extremely important promoting the individuals independence. In part 4 we must consider the whole process of rehabilitation especially considering their home environment. Exercises lying in a sideways position are the most effective form of task specific strengthening exercises that have a greater impact on the potential re-establishment of movement in bed for individuals, along with developing greater coordination in the homo-lateral structure, which could eventually lead to the possibility of balance control and walking. Exercises are structured to consider the need to relearn the movements themselves, then progress towards making them more practical activities of daily living (A.D.L.) movements, where the movements will be required throughout the day (with some assistance initially), removing this support over time as the skills develop towards independence for the individual.*

*Training/learning requires repetition by variation of which there are a wide range of exercises to choose from, which require load bearing movements which help develop better coordination and muscle power. To provide a complete package of recovery, every movement will be discussed and analyzed, to identify the best movements with the least level of assistance as a starting place, to increase the overall potential of reducing this assistance towards independence in the future.*

*The appendix provides information on the training of limbs (Especially the arms) using the chain rules. Too often we start with an 'open chain' which can sometimes be too strenuous for the individual and can sometimes be very challenging affecting the individuals performance and overall motivation to achieve their full potential. Training using the variety of method of the chains enable the tasks to be more achievable, so by using these learning/training rules can promote better recovery.*

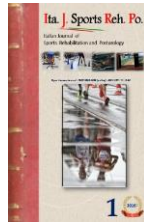
## Introduction

Part three ended by looking at the training for assisting individuals to develop better movement whilst in bed when transferring from the back onto the side. We also discussed the need to train the movements when in a sideways position, considering how to move backwards and then forwards. Whilst on your side, this movement is always performed in combination with the movements in a sideways position. Therefore as we (normal senso- motoric) turns, will still lay on the same spot. We use your keypoints of the diagonals (the shoulder and hip) to lift their upper or lower body, enabling us to be able to place that keypoint either forwards or backwards as required.

This movement has a high of selectivity which can be challenging for individuals who have had a stroke. This can be observed on both sides of the body (affected and unaffected) due to the diagonals being incomplete.

In bed the individual with an stroke must learn and exercise:

1. Lying on your affected side you must also can move sideways to the back and the front of the bed. But this is very difficult and will be not possible in the beginning
2. Lying on your not-affected side the same as in 1.



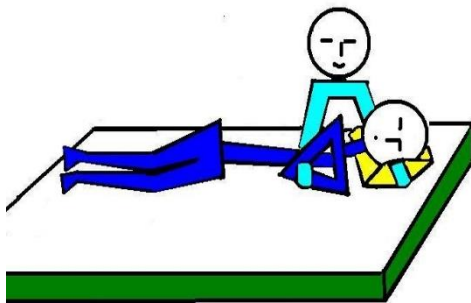
3. Last but not least, turning from the supine position in an side position and to the affected side and the not-affected side.
4. In the bed go up and down on your back .

**What happens when individuals are Lying on their affected side when considering a backwards or forwards movement to the front or back of the bed?**

### Upper trunk

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Initially the majority of individuals following a stroke require assistance to move on their affect sides. Practitioners can help to make a difference to this, from the beginning when considering the differences between ADL/transfers and exercises. The upper trunk requires an appropriate level of tone with the same changes occurring simultaneously in the shoulder blade and an part of the arm. Lifting the head up can provide the required changes in muscle stimulating the back and front diagonals towards the affected leg along with the tone of the unaffected leg which can result in a similar reaction in the affected arm. To enable the head to lift, the momentum must come from the upper arm and glenohumeral joint . Here a pushing movement from the elbow will help to lift the shoulder up allowing the rest of the movement to be achieved. The keypoint shoulder is required to perform this movement as the shoulder blade has a fixation on the thorax and the glenohumeral joint creating a single unit, which is often not always the case.

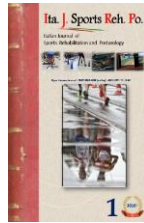


**Picture 1**

#### **Picture 1.**

*Shows how we can teach the patient how the movement feels. Both hands and arms are under the patient, one under the head and one under the ribcage at the height of the distal point of the shoulder blade. Ensure that you are able to reach through to the front of the body with your hand. Now we can facilitated the head lift and then by turning the body slightly we can stimulate movement backwards or by turning towards the front we can make the forwards movement easier.*

The ability to feel the movement is very important, as following a stroke an individual's level of perception tends to be affected, and the loss of generating the correct muscle tone. Therefore by creating a new senso-motoric track for this experience this can restore recognition of the movement. Start with lying down in a specific position so that the shoulder blade is against the ribcage. The border of the shoulder blade must be not palpable. Photo 1 shows the border of the shoulder blade when it is away from the ribcage when an individual is lying on their unaffected side.



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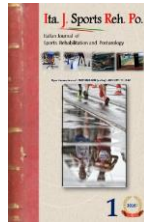
**Photo 1.**

*The dotted line follows the border of the shoulder blade which is between one to two cm away from the ribcage.*

*The glenohumeral joint is in a 90° anteflexion and the shoulder blade requires a laterorotation position. In this case the position is on the same spot as when the arm is not in anteflexion. That means that the head of the glenohumeral joint is positioned against the top of the shoulder joint placing pressure on the structures between the head and the top of the shoulder joint. This can result in discomfort or pain for the individual. Therefore it is very important that the shoulder blade remains against the ribcage and the practitioner needs to ensure control of the tone does not become increased too much taking measures to lower this as required.*

**Photo 1**

When the individual lies on their affected side ensure that you cannot feel that border of the shoulder blade. If this is not the case, bring the shoulder blade more towards the front. That is the correct start position, so now the glenohumeral joint has a fixation point which can often result in the individual being able to move their arm slightly. From this position we can start the exercises. When lifting the head and try to perform the movement the therapist uses their hands to repetitively perform a variation of movements. The movements can initially be varied by asking the individual to move their head first in the direction of movement, by push their elbow into the surface and for example turning the upper trunk towards the front or back before the movement take place. The intensity is measured against if the individual cannot perform this movement independently (more than 100% R.M.) By helping then the practitioner can help to lower that burden creating a task-specific exercise which not only has positive effects on the movement of the upper trunk but also on the affected arm. The backwards and forwards movements of the upper trunk is a natural movement we perform using our shoulder and upper trunk which is often affected in individuals who have had a stroke. This enables the practitioner to support the individual to train in a specific movement of the arm (Differential learning). When



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there is a degree of selectivity then we can use this to promote the movement of the scapula over the ribcage. In this position the scapula becomes the important point when moving the upper trunk backwards, the scapula must make a protraction movement, therefore creating a concentric contraction of the front diagonal on the affected side. When the individual is moving forwards, this will create a retraction movement. During this movement the practitioner can provide a level of resistance, so now we are able to exercise the coordination and power of the muscle of the scapula and also the front and back diagonals on the upper section of the affected side.

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### Lower trunk.

Normally we do this without thinking which is important for the individual to realize. Try not to explain to the individual how they should be performing this movement, **just allow them to feel it**. By performing this movement the individual will be able to feel:

1. There needs to be a lifting movement requiring the homolateral part of the lower trunk, especially the hip to achieve this. This is the most selective part of our diagonals and many individuals with stroke will complete this movement when walking independently without any aids and stabilized the pelvis lateral as a consequence. Therefore it needs to be part of the exercises to improve independent movement whilst in bed, along with having benefits for better movements out of the bed, such as standing up and walking.
2. After the lift movement and flexion of the hip, this enables the individual to move the buttock backwards. Flexion of the hip requires a cooperation of the front and the back diagonal to fix the pelvis and allow the hip to move into flexion using the large hip flexor.

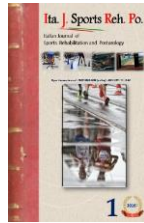
Lie on a bed on your side and try not to think about the movement, just do it.  
Move backwards and forwards with the upper trunk but don't lift your head.  
Not one inch! You should find this movement impossible!!

Now make the movement with the lower trunk but don't lift the pelvis. You  
should remain in the same spot. Now imagine you are lying on your side and  
have pain, what can you do?

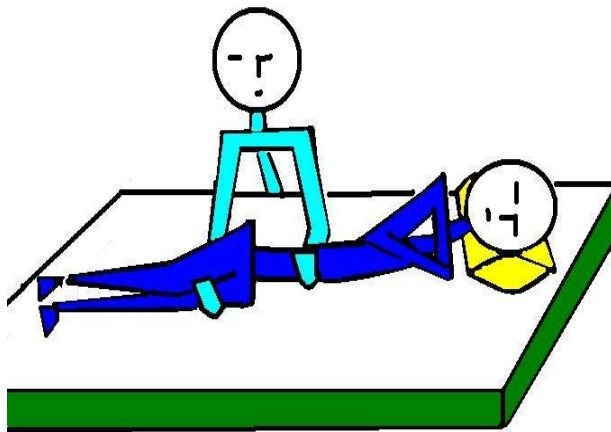
Try turning onto your back!!

3. When the hip is extended the individual can then move forwards. This extension requires action from the back diagonals, especially the m.gluteus max.





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**Picture 2**

*How we can teach this movement to individuals who have had a stroke. They can have a difficulty lifting their hip up from the bed and therefore this movement becomes difficult and challenging when trying to move to the back or the front. Most individuals find moving to the front the most difficult part when they are capable of performing the lift. And therefore it is probably wise for practitioners and client to work on the technique by moving backwards first.*

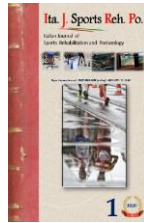
**Picture 2**

### **Performing the lift first.**

Place one hand all the way past the upper edge of the pelvis and the other under the thigh. Then move the hands closer together, this provides the individual with the sensation of what the lifting movement would be like. The practitioner asks them to try and make that movement which often they are able to comprehend what this movement would feel like and therefore produce a short lifting movement. This lifting movement is not always possible without any support unless the R.M. is 100% and cannot always be repeated, but due to the facilitation and support offered the practitioner can reduce the overall weight enabling more muscle strengthening to undertake the exercise. That will initially provide better coordination and then later on more power to the muscle.

Sideways movement further backwards.

This movement is possible with a short lifting movement by abduction of the hip-joint, although we need to consider how the individual with an stroke feels this movement and then how they perform the movement backwards. The movement itself requires a flexion of the hip whilst fixing the pelvis which is required for this movement to be possible. The practitioner can offer support for the individual to feel this movement by gently pulling them backwards following an initial rotation of the upper part of the pelvis providing that the practitioners pulls with their hands in the same position and in the same spot as they were when performing the lifting movement. This is required to enable the individual to experience the movement stimulating the damage area of the brain providing a stimulus it can use to search for a solution. As the individual increases participation the practitioner can then build additional exercises onto this movement, working toward independent function. This provides the individual with a movement and resistance of 75% R.M. developing a better coordination and power as the exercise regime increases.



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### Forwards movement.

This can present the individual with quite a challenge. One reason for this is the need to move from flexion in the hip toward extension lifting the hip with the knee /under leg and the trunk . Therefore it is wise to do this on their front often works better. Then the practitioner is required to do an lift and pull (rather than lift and push when working from the back).

What's important is to create a lifting movement that simulates the correct sensation of movement in this position.

Often there is an question of the individual can use his unaffected arm or leg. By the movement to the back the arm can help , to the front also but in both occasions there must be an lift and movement in the affected side.

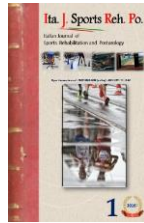
Moving the lower trunk with support of the unaffected leg is almost impossible and makes often the movement heavier.

*These exercises are extremely difficult therefore it is important to start early but they need to remain part of the routine throughout. Individuals with status following a column fracture complain that their possibility for move in bed whilst on their affected side are also difficult. This is due to the homolateral structure not receiving training to undertake this movement when they are lying in bed and therefore individuals change their sleeping behaviours to find a comfortable position in which they can sleep. The training is focuses on walking, stairs climbing and standing up etc. but practitioners sometimes still forgotten how complex this movement in bed is.*

### Lying on the unaffected side and moving sideways.

Lying on the unaffected side enables the upper and lower trunk areas to move more freely, but now the difficulty rest with the amount of control over the affected side. Additionally practitioners need to remember that the front and back diagonals are in effect halved. Individuals who have experienced a severe stroke usually have problems lifting their heads and as a consequence of this lifting movement being restricted, the tone that is necessary to get the load off the shoulder girdle isn't enough and consequently this movement cannot be performed. This restricted movement results in a turn towards the back or front with all the negative effects. The moment the individual with an stroke can lift their head up, connection between the upper trunk (on the affected side) and the lower trunk (on the unaffected side) is established and as a result a more selective movement of the upper trunk and the scapula is now possible. Any activity of the unaffected side will always create an increased tone on the affected side and therefore we can observe an increase in the tone of the upper trunk and the scapula which is mostly a retraction movement. This results in the ability to move backwards is usually easier, but usually ends in a rotation. Additionally any movement to the front remains difficult and even if performed remains very short. Therefore more stability is required in the lower trunk.





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#### Photo 2.

Training for a backwards movement (A front movement is also possible but is more difficult and requires stability by using a pillow under his stomach).

The practitioner starts by building a stable position which is required more in the lower trunk area. Therefore we place the unaffected leg in extension and the affected leg in flexion on a pillow to create stability.

Start by using the exercise for head lifting. After removing the pillow towards the back. Then holding the individuals head push on your elbow and move the trunk backwards. Do this movement together with the individual on the affected side. When moving to the front, try and take the pillow away (although sometimes it is wise for the pillow in the back to remain making it easier to perform the movement forwards).

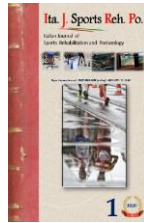
**Photo 2**

#### Exercises 1.

Lifting the head into a stable position and test what the R.M. is. When this is 100% only perform the movement once then 5 minutes before trying again. If the individual have a greater level of ability then offer more resistance not only in the lateroflexion movements, but also by providing more variation with the head lifting. The reactions can be observed in the trunk and legs, providing valuable information on the reaction potential of the diagonals.

#### Exercises 2.

Lifting the head and move the upper trunk backwards. This can present as a difficult movement, by performing it in collaboration with the individual by placing one hand on the pelvis and applying some pressure. Now the stability will be further improved due to the diagonal which start in the unaffected arm having a fixed point on the affected side.



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### Exercises 3.

Any movement forwards requires the upper trunk and the scapula to adopt a retracted movement doing this simultaneously just as we saw in the affected side. Ask the individual to lift their head and place it a little further forward on the pillow, this provides the upper trunk with greater extension of the spine and makes it easier to move the scapula into retraction. Placing pressure on the pelvis and a short lifting movement on the affected shoulder can make it easier for the individual to perform this. Facilitation (an idea out the N.D.T.-Bobath concept) identifies how this helps to increase the potential of this movement . Therefore without this facilitation the R.M. is more than 100%, with facilitation you can lower the loads and repetition is more likely, enabling the individual to be able to start training. A 10 R.M. = an alternative method which provides the right load.

### Lower trunk.

To lift the lower unaffected trunk/hip area, the individual must work with their homolateral structure alongside the front and back diagonals. When more flexion is created in the hips moving backwards or with the back diagonals itself, the individual can create even more extension in the hips and move forwards. Often the power in the lower trunk is not enough to lift the total lower trunk and consequently needs the upper trunk on the unaffected side to support. This increases the pressure from the head onto the pillow. When too much and bracing the movement than make the pillow somewhat flat and the support is limited. Although we can used the position within photo 2, sometimes by bending both legs in a similar position provides a better solution (photo 3).

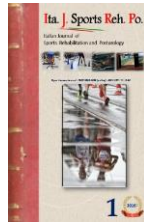


**Photo 3**

#### **Photo 3**

*Both legs are bent in a 70 degree angle, which is the best position for assisting movement forwards and backwards. The weight of the affected leg can potentially hurt the unaffected leg therefore place a pillow between the two legs to reduce the risk of this.*

*But the normal way is with almost straight legs. With the knee bended it is easier but not far.*



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## Exercises 1

Start by lifting the hip off the surface of the bed. Place both hands under the lower trunk and the upper leg and move the arms/hand towards each other and signal to the individual to try to lift their hip off the surface, (homolateral action) Although the diagonals starting from the upper trunk and extending into the lower trunk, they are not complete and therefore we may see a reaction within the affected side. This can result in either an extension or a flexion synergy in the affected leg which creates increased issues for the homolateral structure to have to deal with. The facilitation itself provides an indication of what the R.M. will be which can help to indicate which exercises and amount of repetition and variation may be utilized, or if severe single movements with an rest periods in between. The ability to lift the hip tends to remain in most individuals, so the lift training itself can be built upon variation by doing additional head exercises, upper and lower trunk lifts and working on sideways movement whilst in a supine position.

## Exercises 2.

Moving backwards ; simulate the movement with the individual first breaking the entire move up into short steps. First lifting, then moving back and immediately forwards again with no rest period in-between the two movements. For the individual to hold the muscle tone itself, is usually heavy if a delay is present, it is actually easier for them to do both movement at the same time.

With this single movement being easier to facilitation helps the practitioner to identify the R.M. and to initiate training exercises.

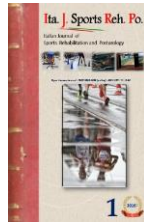
## Turning in Bed

This is one of the most difficult movement that an individual needs to undertake. This requires increased needs for selectivity and an cooperation between all the diagonals with the key points providing the fixation point needed to support the movement.

**Normal when we turn towards the left, we start at both end points of the body on the right side!**

1. As we lift our head from the surface of the bed we push lightly with right leg. This movement requires the diagonal on the front starting in the right shoulder and the back diagonal on the right starting in the leg. The front diagonals from the right shoulder create flexion in the left leg whilst the push with the right leg provides an extension in the left shoulder. In turn this creates the 'kick- off' propulsion required for the turning movement with flexion in the upper trunk – (right front diagonal) and the push with the right leg (back diagonal). Normal we do this with almost straight legs.

2. As we turn further the left leg moves towards the surface and makes contact with bench/bed, to make it possible that the individual lift the right leg and cross it over the left leg. This results in the front diagonal of the upper trunk (right side) being in flexion. This is only possible when the left leg creates an extension to support the whole body. The left is now more controlled via the back diagonals. Again normal the left leg is almost straight because the control is now possible through the foot of the left leg ( lateral side)



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3. When the lower trunk is in the correct position the individual can now lift the lower trunk and move it backwards. This because the lateral side of the foot create an support and stability that makes it possible to lift and make flexion in the hip and go with the lower trunk to the back.
4. After this the individual needs to correct the upper trunk by lifting the left arm upwards and backwards so we lay on our left side in the same spot as we started on our back.
5. The individual is always capable of stopping the movement, because our arms act as anchors to help in balancing and slowing the movement towards a full stop. Additionally the leg that lies below on the surface of the bed has capacity to brace the movement.( Exorotation in the hip gives an pushing of the lateral side of the foot in the bench/bed).
6. The tone and power of the muscle to complete this movement is very small, even when an individual is sleeping there is sufficient power and tone to complete the movement, which is mainly due to the selectivity between the diagonals being significantly increased.

**What happens in individuals who have had a stroke when they undertake this movement?**

#### **A. Turn over the affected side.**

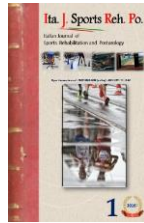
Individuals who have had a severe stroke will have increased difficulty lifting their head when turning to the affected side, because the diagonals control diminishes in abdominal area resulting in the potential to be able to lift up but not turn to the affected side. Therefore individuals in this position may try to push with the unaffected leg which creates an extension in the back diagonals, but because the head does not lift they cannot move further and cannot start turning.

Individuals who have had a moderate stroke will need to build up the flexion with slight rotation in the upper trunk. The pushing movement for propulsion is still with the unaffected leg but the level of control is significantly reduced, through weakness in the affected shoulder and affected leg resulting in the final phase of turning movement being more an uncoordinated falling movement. The affected leg will go in flexion and not in extension to support the movement of the not-affected leg. Therefore we see often individuals try to lift the unaffected leg too early to brace the movement which results in an uneven weight distribution and they will usually fall backwards into a supine position once more. Further correction of the attitude and position when lying on the side then moving to the back is often not possible without assistance. The brace of this movement cannot be done by the affected foot and because exorotation isn't often possible in the hip.

The 'keypoints' (shoulder and the hip) and the homolateral structure are very important for this turning movement. It is difficult to turn and especially brace movements due to the dependency for both the arms and the legs to be functioning. Therefore this exercise is required to promote the optimal recovery for the individual.

**Practitioners should also consider other aspects such as the individual being able to hold the blanket when they turn by using one of their hands to grasp it!!**





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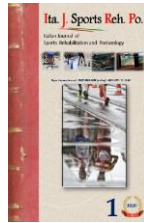
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*Difference with normal motoric ;*

- No straight legs
- Flexion of the right leg (part of the front diagonal will be stop to help the upper trunk to make more flexion.
- The right arm goes to the surface and start with the brace of the movement.
- When the turn is almost complete the right leg is than the stabilisation by exorotation in the hip supporting on the lateral side of the foot but that ask for an straight leg.

**Photo 4,5,6**



#### **Photo 4. Right side affected.**

*Turning to the affected side.*

*Note how it commences with a good lift of the upper trunk and the left arm is across the chest, but the right leg is in flexion and is therefore incapable of holding the extension resulting in the leg having no influence over the bracing movement. The left leg provides a push that is quite firm because as we can see that the arm goes into flexion synergy which is part of the back diagonal.*

#### **Photo 5.**

*Now we can see how much flexion the right leg has. Therefore the upper trunk needs to work harder to increase tone in the front diagonal, with no fixed point because the right leg has moved upwards and cannot support the front diagonal with further shortening which is required. The individual therefore pushes harder with the left leg providing increased tone in the upper trunk extension making it difficult for the upper trunk on the left side to shorten and to rotate.*

#### **Photo 6.**

*Now on the side .*

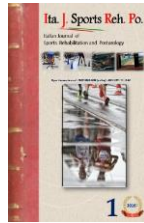
*Notice the brace and turning movement with his left hand. The tone in the right arm/hand has decreased and we see uncoordinated finger movements and a decrease of tone in the elbow. Both legs are bent resulting in the right leg only being able to brace the movement in the hip. But is the hip capable to give an selective exorotation and on which point in the turn. Often at the end and that gives the individual with an stroke the feeling of an fall (out of bed). The flexion in the hip and knee is so great that the foot does not rest on the surface of the bed. And this whole movement bring him to the edge of the bench, he is not capable to lift the lower and upper trunk backwards and lay in the middle of the bench, on the same spot as when he start turning.*

It's quite an effort to turn onto the affected side. Now imagine lying under a blanket transferring from the back to the affected side is now more restricted by the covers.

### **B. Turning over to the unaffected side.**

Individuals who have had a severe stroke are incapable of lifting their heads into the required position to take the affected side into protraction and extension-rotation and are incapable of pushing using the affected leg too. Consequently they will try to pull using their unaffected hand whilst pushing with the unaffected leg which results in more action in the back diagonal on the opposite side culminating in little to no movement. Practitioners need to be aware of the danger that can arise when an individuals who has had a severe stroke tries to turn and is incapable of lifting their head off the pillow, as if unmanaged it can be fatal. Individuals who have had a Moderate degree stroke sometimes have great difficulty with the protraction of the shoulder during the rotation phase. When the affected leg is capable, the individual will push with it to start moving the lower trunk in a turning motion which is proceeded by the head and the upper trunk moving in the same direction. When the protraction of the affected upper trunk is improved then the turning movement towards the unaffected side also improves, although we tend to see more grand exaggerated movements instead of smaller fine motor movements. As a consequence turning whilst the individual remains in the same spot on the bed instead of moving either backwards or forwards during the move is the last skill to be achieved.





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### How to start retraining?

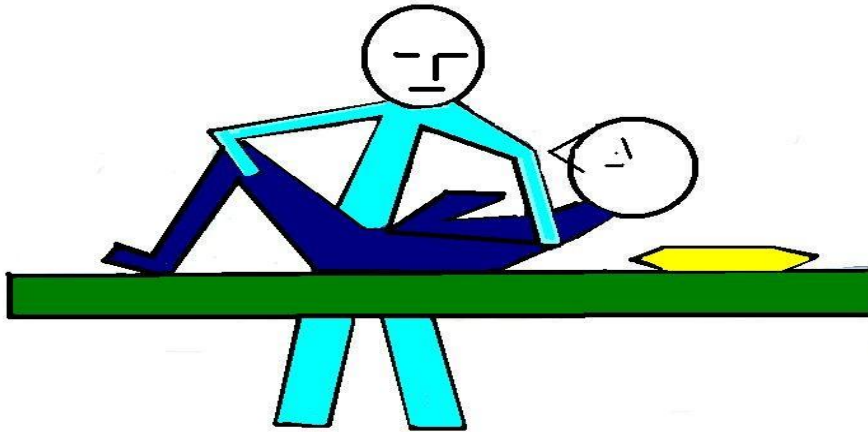
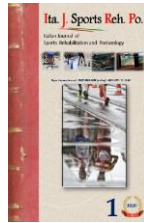
Two specific elements must be developed during training.

1. The movement that is required, needs to be incorporated into the ADL of every individual with a minimum of assistance by others. This creates less dependency and more independence for the individual. Therefore priority must be placed on being able to turn onto **the affected side** before the skills of washing and dressing.
2. To promote such improvements we must look at training being task specific to help stimulate better coordination and muscle power, and this provides the focus of the training over the period of recovery aiming to improve more complex skills such as balance and walking.

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### The ADL movements.

Initially the individual is incapable of turning independently, requiring assistance but as practitioners we must ensure we encourage as much cooperation from the individual to empower them to recover as much skills as possible which often requires a 1 R.M. When turning we require the front diagonals to be involved which in turn requires the head to be lifted allowing sufficient time for this to be done. Individuals who have had a severe stroke may still be able to perform this, but when bracing during the turn movement this can be a particularly difficult movement, but is not always the main concern of care providers. The start of the training is the job of the physical therapist on the bed of the individual with an stroke. This is the only way to train and learn independent turning in bed. Thus first the movement and then as a part of the ADL.



### Picture 3:

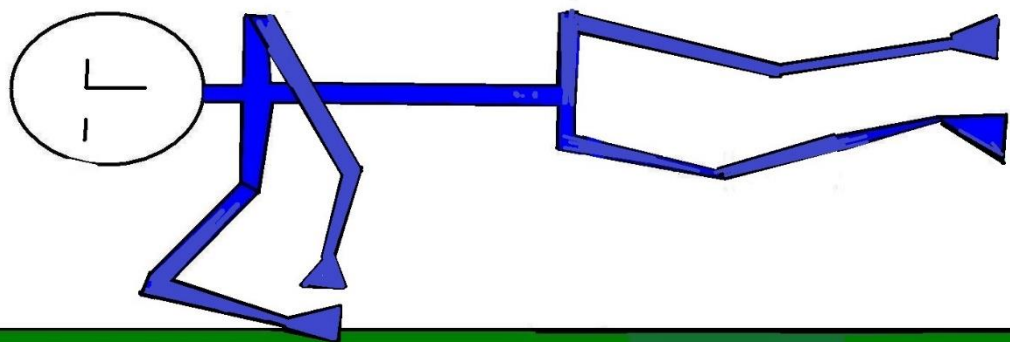
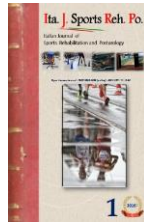
*When turning to the affected side, practitioners get the individual to bend both knees and we push with our hand placed on the knees down. The other arm provides a flexion protraction stimulus to the upper trunk. It is easy for the client to lift their head and try to move over to the unaffected side. For individuals who have had a severe stroke it is advisable for practitioners to stand always on that side the individual is going to turn. The push on the knees must be held till the individual is lying on his side, otherwise he feel that he is falling. Normal are the legs more straight and can someone brace the turning movement through an action of the hip- exorotation- that will give in the foot on the lateral side an resistance to the turn. But in the beginning it is easier to bend both legs but be aware that in the last part there is no control.*

When assisting individuals in turning, practitioners tend to maintain pressure on both legs for the entirety of the move, this results in the individual not experiencing the falling sensations in the final part of the turn. Both knees are bent to stabilize the movement. When one leg is in extension the movement continues and is less stable and as a consequence the individual will roll with the movement and feel less control. Due to this reduced control in the movement there is an opposing reaction that occur where the head position becomes extended (upper trunk moves backward with extension of the whole body. This is referred to as a static reaction, 'Tonic Labyrinth Reaction', we will discuss this in another part of the series.

When the individuals condition starts to improve, practitioners should aim to reduce their level of support encouraging more independent movement in turn consequently the bending of the legs becomes less important overall with one exception, which is when swinging the legs out of the bed, here it is wise to turn with the legs in a bent position. Turning with almost straight legs will be first possible on the unaffected side and on the affected side it is dependent of an active exorotation of the hip. Is that present than can also the knee when the leg is more straight give an brace instead of the foot.

### Task-Specific Exercise.

Start with the individual lying down in a sideways position. It is best to start on the affected side, as the keypoints which are required for this to work need to be those which support the weight, which are located on the affected side.

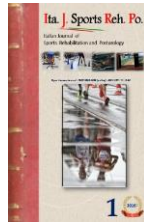


**Picture 4.**

*Practitioners start by placing the individual onto their affected side taking care of their affected arm. Ensure you allow for enough protraction in the affected shoulder and placed the arm in such a way that when there is a clear reaction which can be used. Often we see extension in the elbow. In the beginning it may be necessary to support the trunk using pillows. Placing a pillow under the head and the unaffected arm/hand help to support the body whilst on the bed. This encourages the development of a stable upper trunk, and with the affected leg bent we can start by lifting the unaffected leg to complete the movement.*

### **Lifting the unaffected leg.**

When an individual is incapable of performing, then one likely cause is not enough power, therefore when starting the training practitioners should focusing on a level which considers ADLs. When the individual is capable of lifting this leg the training can commence. Lifting can be 1 R.M. with a single lifting movement being enough encouraging a period of 5 minutes rest before trying again. Practitioners usually observe significant amounts of reaction on the affected side. Some individuals lift their head which can increase the tone of the unaffected side from the upper trunk and provides a sufficient reaction in the other parts of the diagonals, but if the individual lifts their unaffected leg, this tends to stimulate the upper trunk on the affected side and we then see more tone and movement in the affected leg.



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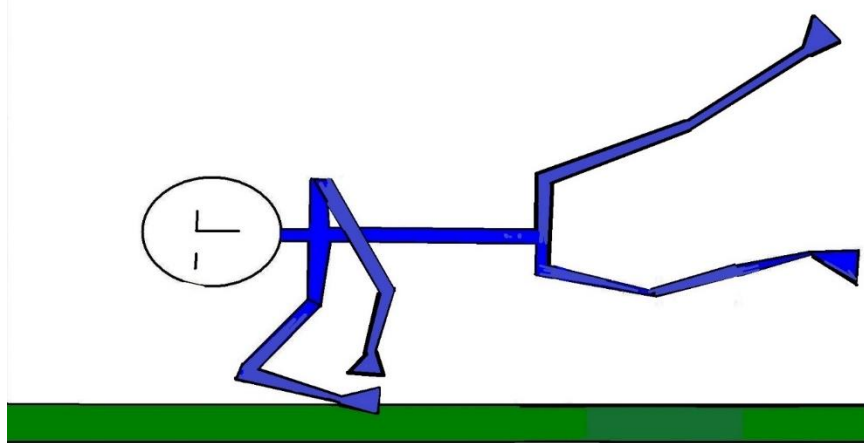
### Now we can start the training.

1. Resistance to the unaffected leg (75% R.M.) for every session to build up the coordination and muscle power.
2. The first step here is to increase the tone and power of the affected side especially in the keypoints. This can be achieved by lifting the unaffected leg higher, making general movements with the leg whilst in the air. Once lifted the practitioner should look at the training to establish how long this position can be sustained and work on increasing this time over the period of retraining. The unaffected arm/hand will be required to support the affected leg diagonals and maintain the body in a stable position. The lifting movement will have a greater effect on the affected arm. The practitioner now looks at supporting movement only whilst the leg is in the air. These movements should be as limited as possible either forwards or backwards as this requires a significant amount of stability, and we need to establish what the individual is capable of doing.
3. Lay the unaffected leg behind the affected leg then try to lift the unaffected leg so that it sits primarily on top of the affected leg then when this is achieved, look at placing it in front of the affected leg. Starting with this movement from back to the front is achieved due to the front diagonal being elongated with the affected shoulder being fixed on the surface of the bed. Furthermore the unaffected arm/hand can help to maintain this position. Following this we can look at developing the movement of the leg from the opposite direction (from the front to the back). When the leg is at the back the upper trunk on the unaffected side needs to go forwards, otherwise the position on the side is unbalanced and therefore lacks stability. Normally a reactive movement of the upper trunk can be observed when the leg on the upper side is moving. Therefore it is important to build up the resistance over time providing more complex movements to enable the brain to establish problem solving skills (Differential Motor Learning).
4. By holding the leg in the air then moving it forwards and backwards. The practitioner can observe a backwards rotation in the upper trunk, when the leg moves forwards, and forwards rotation when the leg moves backwards. These movements are only achieved fully when the diagonals are working together.
5. Now look at performing the exercises with the affected leg more in extension. You should observe the affected leg having to work particularly harder to maintain the sideways position on the bed. The whole leg including the foot will work when the function is present.

### Picture 5

*The affected leg is in the air, this requires a concentric contraction in the homolateral structures of both the affected and unaffected sides. This should be an exercise routine which is repeated in every session and can be done with resistance (75% R.M.)*

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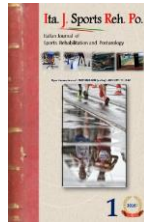


### Trunk rotation with the leg in the front.

1. Movement of the unaffected leg forwards requires activity of the homolateral and back diagonals in the unaffected side that is part concentric (lifting) and eccentric.
2. The leg when moved forwards can become too heavy to maintain in that position and the body will fall away from the bed, therefore the practitioner may observe a rotation in the leg to counteract this and maintain the affected leg on the bed surface. This is usually an exorotation which requires the homolateral and the back diagonals (m.Gluteus maximus) to work in a concentric activity.
3. The upper trunk of the unaffected side will be acting in collaboration with the affected leg to produce an extension rotation backwards, (concentric movement).
4. At least the upper trunk on the affected side will be stimulated to maintain its position against the forward movement resulting in extension of the glenohumeral and elbow.

### Trunk rotation with the leg behind the body.

1. The unaffected leg must lift, which requires concentric activity of the front diagonals and the homolateral structure.
2. The affected leg will start moving in endorotation which is required to be prevented by concentric exorotation. This is an action for the m. gluteus maximus and is often the first time we feel concentric contraction.
3. The upper trunk on the unaffected side will start to move backwards due to the weight of the leg which is behind the body. Therefore we must counteract this by producing a moving active forwards (a flexion rotation).
4. The affected arm/shoulder needs to act as a fixed point which allows the upper trunk at the front to turn forwards. In the beginning there will be limited activity, but when the leg is lifted behind and moved forwards the activity will become greater.



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### **Training of the turning movement.**

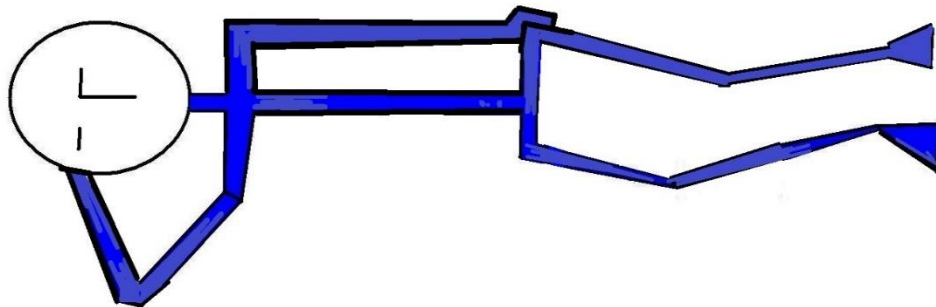
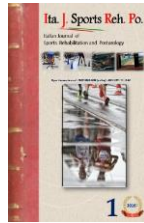
Starting in a sideways position firstly place the unaffected leg on the bed and then rotate the pelvis on the surface of the bed. Then reverse this movement, rotate pelvis back then return the leg to the starting position. Following this look at doing the same exercise with the upper trunk. Holding the legs in the sideway position encourage the individual to rotate backwards turning the upper trunk towards the surface of the bed, then the legs will follow afterwards resulting in a supine position being achieved. When working with the individual to exercise towards returning to a sideways position, it is often necessary to start with the legs looking at developing a higher tone. The practitioner can look at practicing this with the individual whilst they are in bed with blankets placed at the end (ADL).

### **Unaffected sideways position.**

When there is limited function in the affected side, it is best not to start with training itself, instead look to working on a level of functioning for A.D.Ls first. When it is time to consider looking at training, start by working on the affected side, this will help work towards restoring function to that side of the body quicker. Practitioners should work on the affected side first because the keypoints are fixed with the diagonals commencing in the unaffected side can be of benefit to helping stimulate the remaining parts of the diagonals in the affected side. When the individual is able to lift the affected leg, the practitioner can then start moving to the next level of training.

**Through this approach we get more power and coordination in the affected side, making the movement when turning from a supine position to the sideways position possible. Additionally it helps to develop the balance and stimulation of the homolateral structure on the affected side more, working to restore the overall function of the diagonals.**

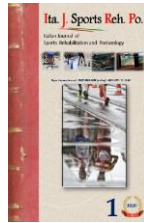




**Picture 6.**

*Starting in a sideways position placing the unaffected arm under the head, this can then remain on a firm pillow. Now the upper trunk on the unaffected side becomes a closed chain and can help to control the body attitude. Then place the affected arm slightly resting on the hip towards the front. Once the individual is in this position, initially start by lifting the leg, then encouraging some short movements. Then commence by placing the unaffected leg in a slight bent position increasing the amount of stability with the leg on the surface of the bed. This can be extended as the function develops by extending the leg fully and using the foot and hip muscles to do all the work in providing the stability.*

What's Important is for the individual to be able to maintain their position whilst the affected leg is lifted and moved. Observe for how the trunk reacts to this movement. When the leg moves backwards the upper trunk should react by counter balancing this by moving forwards. The unaffected leg together with the unaffected arm begin to work harder, this results in a greater reaction in the upper trunk (on the affected side) increasing the tone amount of reaction and flexion synergy. Due to the individual having to recover from the previous damage to the brain, this change in the need to solve this problem increases the range of possibilities that are available to them over time. It is useful to be aware that after exercise the mobility and the tone of the leg is normalized. If the reaction appears to be too high then it is useful to have pillows to help create borders enabling a good of upper trunk rotation forwards as the affected leg moves backwards, or in the opposite direction if the affected leg moves forwards. Initially only consider lifting and moving the affected for exercise, and delay laying the leg flat on the surface of the bed. Practitioners should notice how heavy the leg can be, reducing the overall number of times this can be practiced. Placing the leg down onto the surface of the bed often results in the tone being reduced making it more difficult to build the tone up. When the individual has developed

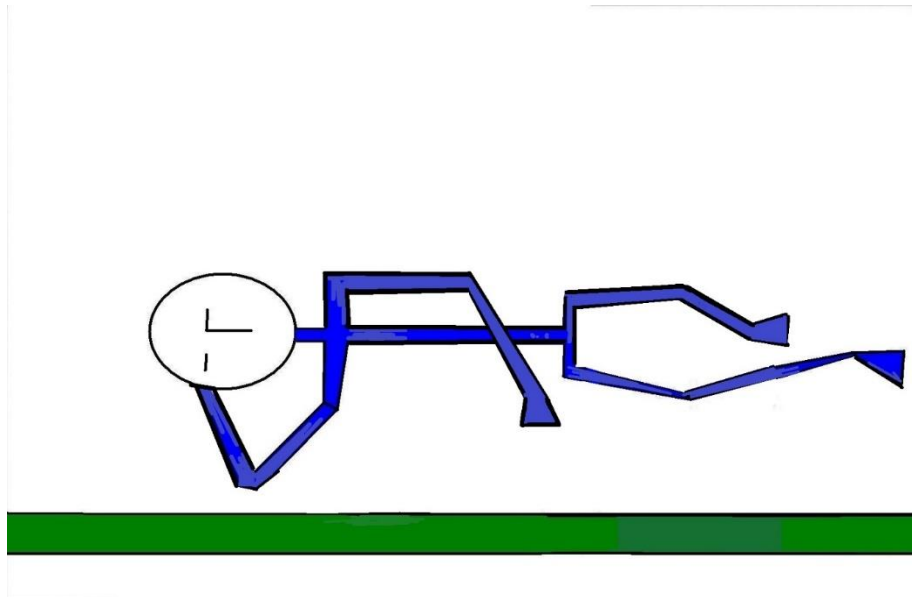


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sufficient power, then you can work together in developing the ability to lift the leg initially from behind the leg and place on top of the other leg, then later look at the same movement when the leg is in front of the other leg, (moving it backwards), before putting both movements together.

**Remember the rule for task specific resistance strengthening.**

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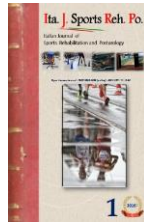
**Note: Following this period of training, the next step is to repeat the same pattern of exercises but now with the individual lying on the affected side.**

**Picture 7.**

*Starting in a position when lifting the leg off the surface of the bed from behind the unaffected leg and placing it on to the other leg. The affected arm is placed forwards ensuring the wrist is positioned correctly. As the leg is lifted the whole body needs to work together, as the weight of the leg will cause the body to start turning backwards. A reaction in the upper trunk particularly in the scapula evokes a flexion synergy and because of this the hand and wrist moves in a palmar flexion which if not monitored can obstruct the blood supply.*

**Task-specific resistance strengthening.**

In part 2 of the diagonals series, we discussed the need for task-specific resistance strengthening to be incorporated throughout the entire training program for individuals who have had a stroke. The article identified how using this approach resulted in benefits for all individuals no matter what level of function they were. When individuals are lying on their sides the amount of heavy work is increased so practitioners can train to develop the coordination and muscle power, whilst each situation requires the brain to be more challenged having to search for a solution. Individuals also get a sense of empowerment, experiencing their potential progress they are making as they become -stronger.



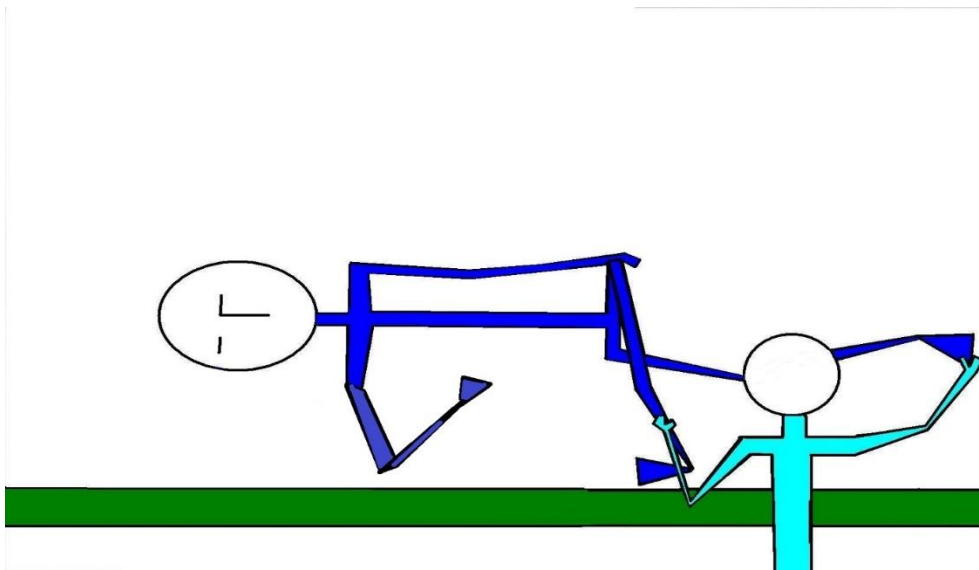
## Co-contraction.

Good task-specific training will provide co-contraction, which is when muscles work together searching for a level of activation which makes the body “rigid”. This results in a concentric contraction of both the agonist and the antagonist elements of muscular function which is difficult to achieve not only in two muscles, but across the whole of the diagonal systems for individuals following a stroke. And not only in two muscle but in the whole diagonal system.

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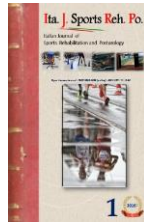
## Balance.

Good balance exercises are achieved in standing or seated position which is when we need these skills more. However when lying in a sideways position we also require good balance, which is predominately managed in the homolateral structure. Therefore we should use task-specific resistance strengthening with the client in this position, to increase the benefits in restoring function.



**Picture 8.**

Whilst lying on the affected side, the individual has the affected leg in full extension with the practitioner holding the foot to both feel and facilitate movement. The unaffected leg is lifted and moved as far as possible forwards. Now the practitioner applies resistance of 75 % R.M. and encourages the individual to maintain the position. This can be repeated up to 10 times. By the eighth repetition you should start to feel the muscle becoming fatigued in the affected leg, but not only in the unaffected leg. Often resistance is not required as moving the leg across from one side of the body to the other using the diagonals structures from the shoulders down without moving the head can be enough. This can also be achieved by moving the unaffected leg backwards. The unaffected hand and arm are incapable of participated in this picture because the individual has lying him on their hip.



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### What will practitioners observe?

#### Co-contraction.

1. In the affected hip: the abductors and the adductors will lift the pelvis from the surface of the bed, but the position is difficult to maintain requiring activation of the muscle that enables rotation involving the hips and lower trunk on both side
2. In the unaffected leg we see the adductors and abductors working together with the lower trunk muscle to position the leg in the right position.
3. When the lower trunk tries to move forwards the upper trunk works to prevent this by using co-contraction, rotating the upper trunk backwards.
4. The upper trunk on the affected side needs to remain stable which is only achieved through co-contraction although remain aware of how extension in the elbow can increase the weight distribution.
5. There will be a co-contraction in the neck muscle.

This is why practitioners need to be careful to ensure the resistance is no more than 75%. Lower can be ok so long as a stimulus to get more coordination and muscle power is achieved.

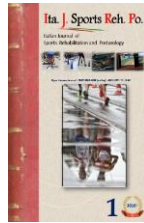
**This means that all diagonals and homolateral structures are working at their greatest potential! Enabling individuals to make combinations, power exercises and speed.**

#### Balance.

Holding this position uses the same muscles as standing on one leg but the stimulus providing information comes not from the foot. This exercises is not a replacement for training of balance when standing (especially on one leg), but does contribute to creating better muscle coordination to improve the overall skills towards being able to stand on one leg.

#### Moving up and down the bed whilst in a supine position.

When moving up and down in bed whilst on your back requires selectivity. When moving up the bed we use our legs to push into the bed propelling us in the right direction. Alongside this we need to also lift the buttocks or walk using our shoulder blades as an alternative. This all requires power in the lower trunk and hips to be able to lift the buttocks, or to have the skills to alternate the weight from one leg to the other to lift each shoulder blade whilst maintaining the weight in the other, to perform a “walking” movement. With many variations be available to use, it is important to ensure either two/three point of contact are made with the body on the surface of the bed, to allow the rest to move. In principle, moving downwards in bed is pretty much the same, although the legs must provide flexion in the knees and the shoulder blade must now make a walking movement downwards. The diagonals used, help to lift the back, but when we lift our left leg the whole body will be controlled by the entire diagonals system (front and back



**Photo 8.**

*The support is now on the right knee and left arm. See how he moves his left knee to the front the right arm is already placed at the front. The support area is always with the diagonals which provides the greatest amount of stability.*

Individuals who have had a severe stroke tend to lack the capacity to do this.

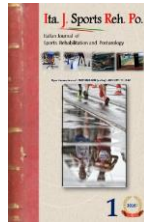
Individuals following a moderate stroke can perform this but require the assistance of a slide pillow under the shoulder/ spine, but will tend to use the unaffected side through an parrot above their head and move only with the unaffected side and that can give an risks on injury to the affected side.

Only when an individual has selectivity in the affected leg, will it then be possible to carries out this movement fully with both sides of the body involved. Additionally we tend to see that many individuals who can walk following a stroke still have limited ability to make this movement in bed. This increases the value of providing exercises to train this movement for all individuals following a stroke. Start with the knee in optimal flexion but be aware that this elongated the buttock muscle and that this muscle must also be able to give an lift with straight legs equal with walking.

Individuals who have had a severe stroke are usually supported to move by using a particular type of aid (slide pillow) which is used to help slide them up the bed into the correct position. When they are assisted to slide, they are usually asked to be involved by lifting their head and pushing with their legs, as lifting up the hips can be quite a difficult. But pushing with both legs is an important base for later – the affected leg facilitated by the therapist or other practitioners – is lifting by the buttock not necessary.

1. Initially practitioners tend not to observe this movement without using such an aid. Which can result in a loss of overall ADL moments over time. Especially the aid – Parrot – because this will lead to an action only from the mot-affected side , arm and leg.

2. An movement always performed by using the unaffected side is very unstable (no diagonal base). Which inevitably has consequences related to risk and recovery.

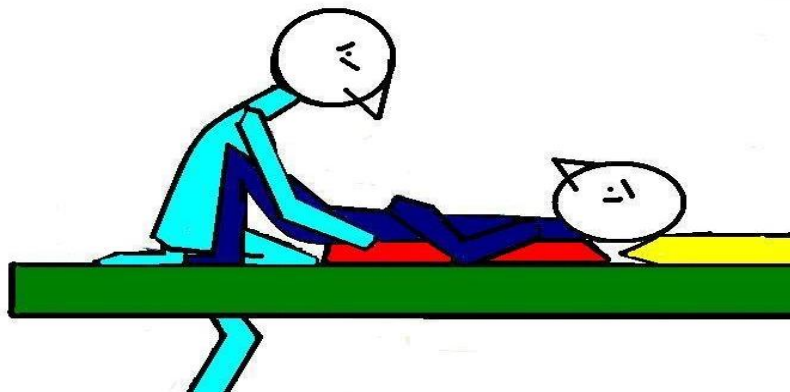


3. For an individual's overall ability to improve, the pelvis requires to be fixed in position through the collaboration of the buttock, stomach and spine muscles on both side. When the unaffected leg is in flexion to push up in bed the affected leg is often in extension and now it is almost impossible it hold the lower trunk/pelvis in the right position.

4. Using the aid above the head will (Parrot) will always has the danger that the individual may lies on their affected arm /hand and create pain or a swollen hand. The use of this aid can therefore be better introduced at a later stage when the skills of the individual towards independent function has improved.

Practitioners therefore need to consider training for this movement the same way as we started with developing sideways movement when in a supine position. Initially train the power of the buttocks to support the process of lifting, then when this is sufficient we can look towards the movement phase. This movement therefore will take quite a while to perform in its entirety and as such only one or two repetitions can be perform each time because it far exceeds a 100% R. M. One way of incorporating this movement is into the A.D.L. transfers itself. As this movement also an exercises, this increases the impact of such an ADL moment, therefore we need to consider who is best placed to support this? The care staff or the therapist? Or both but the therapist train and learn the individual to do it with two legs and teach the care staff to introduce this in the ADL !

Realize that the start is with bended knees, because the buttock certainly on the affected side has an elongation necessary to get an action. But when this is use in the ADL , the therapist must exercise further because bending knees isn't normal . This movement in bed will normally be done with the legs almost in extension and that ask for further exercises to get there.

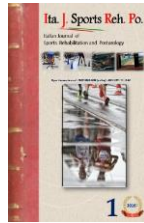


**Picture 9**

*Here is an impression of the movement up and down the bed whilst using the slide pillow aid. Ensure that the support is directly under the buttocks and far enough under the upper trunk, that the patient can lift his head. That is an moment of increasing the tone of the front diagonal.*

In picture 10 the practitioner/ therapist has bend the individuals knee and placed it between their chest and upper arm. The practitioner are situated on affected side so they can help facilitate the lift of the buttock and the pushing (up) or pulling ( down) movement on the legs. This approach helps to stimulate the lift of the buttocks. As the power increases with the individual then the same movement can be developed without using the sailing aid.



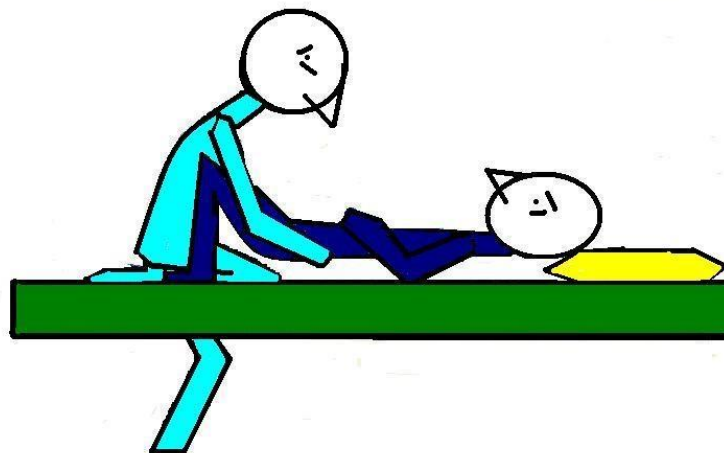


**The ability to move in bed is important and needs to be considered through the whole rehabilitation phase and should be encouraged to continue afterwards too.**

**The Importance cannot be emphasized enough from practitioners.**

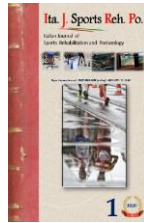
**Picture 10**

*Without the slide pillow aid, the individual now has sufficient power to lift their buttocks enough with assistance they can begin moving up and down the bed surface. Very difficult stay the movement with the shoulder blade. Therefore often clothes such as the T-shirt do not slide as easily due to the weight of the individual passing through their shoulder blades, the clothing can therefore become restrictive, so it is worth to place the shirt for the transfer a little bit in the direction of the head and prevent the pressure on the front of the neck.*



When the individual is capable of lifting and supporting their weight with the use of their buttock muscles, it is then possible to consider looking at the movement phases of the exercise, firstly the extension – pushing movement up the bed, and flexion pulling movement down the bed and look towards developing addition correction with the shoulder blades movement (walking). Initially with flexion of the upper trunk, and later it is possible that the patient can develop a “walking movement” using the shoulder blade for support and more extension in the upper trunk.

The program is almost the same as that of the sideways movement which we discussed previously only the walking part on the shoulder blade has some variation. Knee bended in the beginning but normal is almost straight!



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### **Walking on the shoulder blade.**

To undertake such a movement it is important for the shoulder on the affected side to be able to make elevations and depressions in movement, either with or without any load of body weight, and that the right diagonal is working, or the individual can move only one limb.

Working with the diagonal movement:

Weight is placed on the right leg and the left leg is moved into flexion (going up), now weight is on the left shoulder and the right shoulder can make an elevation (moves upwards) or depression (moves downwards). Elevation with the shoulder blade in a shortened position can be very difficult and requires greater selectivity.

Applying any resistance will only be beneficial once the individual can undertake the movement with some level of ability, then the practitioner can consider task-specific resistance strengthening from this point.

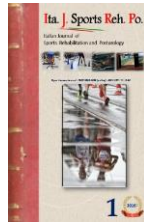
### **Coming to a sitting position through both sides and maintaining this position.**

An individual who has had a stroke will require a level of retraining to undertake this movement on both side for to improve their overall independence, but usually in a rehabilitation phase of recovery, practitioners tend to focus on the affected side only. That is the same when looking at the A.D.L. activities too, as stimulation of the brain helps it to develop solutions to be able to undertake the movement. Exercises for the trunk in sit position is a useful way when looking at supporting the individual in washing and dressing, this can help to develop greater stability, which then makes it possible to develop these skills further an also the sitting position.

T.C.T. or Trunk Control Test is one of the most important test practitioners can do to evaluate the progress of the individual. The test itself consists of 4 particular steps:

1. Turning to the affected side (Score If impossible 0 points, with assistance 12 points, Independent 25 points)
2. Turn to the unaffected side.
3. Moving to a sitting position
4. Remaining in that sitting position for at least 30 sec.

Let's consider the next picture (Photo 9) and see how this individual would have scored.



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**Photo 9**

*The sitting position is held with assistance for 30 second. The trunk has bent totally whilst holding onto the edge of the bed. The nurse supports here lower trunk .*

The affected side (photo 9) is low in muscle tone, see the difference between the shape of the legs. The affected leg is almost flat in comparison. Also the position of the head is in an antero-position, where the individual pushes their head in a cervical extension forwards to maintain stability. This is due to the activity of the front diagonals together with the back diagonals being incapable of stabilizing the pelvis.

As a result of the instability in the pelvis it now rotates backwards collapsing the thoracic spine into flexion and therefore (B. Engström) the cervical spine make this antero-position adjustment to rectify the loss of stability. All this has an effect on the muscle at the front of the neck resulting in limitation for eating, drinking and swallowing functions.

When sitting in this position there is a load distribution greater than 100% R.M. so practitioners must consider shorter period because sitting in this position for any prolonged time can alter the muscles increasing the risk of limitation for the swallow function.

The T.C.T. for this individual therefore is:

Turn affected side 0.

To the unaffected side 0.

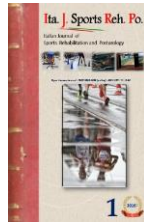
Coming to sitting position 0 and

Sitting for 30s 12.

The greatest barrier for individuals to overcome are the movements in bed to come to a sitting position. Once in the sitting position in the beginning, support can be offered through the use of a good chair or wheelchair. This means exercises above ADL level and that is an job for the physical therapist together with the other care givers, **but the physical therapist must be the first !!**

Normally individuals will get up out of bed by lifting their head and upper trunk, this will than activate the legs to go into flexion in the hip, then by rotating to one side, we can move the legs over the side of the bed, (together or separately) independently or with some support from the arms for propulsion and stability.

For individuals who have had a severe stroke the ability in the lower trunk is significantly reduced, increasing the potential of being able to come to the sitting position. Therefore the training is separated into 2 specific movements to help recover these skills. Initially by turning



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to the side and then coming to the sit position from this position follow by a special transfer (low transfer) into an wheelchair. This is one of the heaviest exercises the individual will undertake, therefore to prevent fatigue it is recommended to undertake this exercise only a few times a day where possible. When the individual has sat for a period of time (one hour) in the chair, they are not always capable of correcting their sitting position and generally transferring back to bed will require an patient lift.

Consequently 3 to 4 times a day will be the every time an training regime.

1. Moving sideways in bed
2. Turning to the affected side
3. Come to a sitting position
4. Making a “low” transfer in the beginning the work of the physiotherapist later one with guidance from the physiotherapist.

#### **Coming to sit position over the affected side.**

Practitioners support the individual into a lying position in the bed that is as far as possible from the edge. When considering how far the length of the upper leg provides a good measure to get an ideal distance possible for the individual, Why? When sitting on the edge of the bed, due to the instability a lot of individuals experience, they may have an increased sense of falling which increases the feeling of being unsafe, especially as some mattresses tend to slope downwards when they are sat on. Practitioners should ensure they create a good area which supports the sitting position. For this approach practitioners now require sideways movement towards the back of the bed, and a turning movement to lie on the affected side. Coming to a sitting position itself is a function of the lower trunk, which in turn requires a degree of muscle tone which increases by lifting the head. The homolateral structure of the unaffected side will be activated and practitioners should observe for a reaction on the affected side. The most important keypoint is the lower trunk /hip on the affected side, this is the fixed point where the diagonals can obtain anchorage to undertake the move.

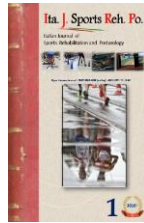
Practitioners need to monitor this anchorage position for muscle tone, power or selectivity. So we need to consider therefore how we can both see or feel for this?

When we move the legs from underneath individually over the side of the bed we look for minimal (if any) exorotation of the affected leg. Normally we see an exorotation when this leg is out of bed and in under lying hip there must be an concentric endototation in the hip to active participated with movement sitting up on the edge of the bed. Now the anchorage is in this hip good.

When there is no exorotation than is that often an sign that there is no active exo – or endorotation possible because :

1. There is no lifting of the head, therefore no increase in muscle tone.
2. The tone of the affected hip can be so low that any increase in muscle tone is impossible.

We can ask the individual to push with the unaffected arm but this is only possible when the lower trunk provides a fixation point. And certainly in the beginning by severe or moderate individual with stroke or when there is an hypermobility in the hip the individual experiences a pain response when no reaction occur in the muscles. Therefore it is very important that we stop the movement by adjusting the placement of our leg (photo 10).



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Try this!

Lay on your side and try to get to a sitting position without using your hand, elbow feet and knees!

You will be able to experience what it is like to have no anchorage and restricted movement!

Consider where is best for the anchorage to be? On the upper trunk or the lower trunk?

Try this again by using one arm to get to sit. Now you can use one leg to sit up. Where was the anchorage enabled you to do this?

We do this before we start the movement to a sitting position.

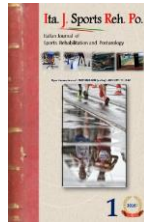
The position of our leg is **far more important** when the individual moves back into bed. Muscle tone is often lower at this point due to fatigue causing the rotation of the hip to be so low that if forces this can cause harm to the structures of the hip by simply lying the patient in the bed. This rotation exercise should therefore be conducted as part of -the whole rehabilitation process from start to finish for all individuals who have had a stroke due to its increased impact.



**Photo 10:**

**Photo 10:**

*The physiotherapist places the right leg so that it supports the affected leg preventing too much endorotation. Moving out of bed this technique reduces the potential for pain in the lower spine. Additionally when moving back into bed it prevents any endorotation of the hip which can cause unnecessary and potentially harmful stretching to the ligaments of the hip. There is evidence to suggest that some individuals who have had a stroke have ruptured ligaments with poor movement making rehabilitation towards recovery extremely difficult.*



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Placing your leg in the correct position to provide support for the individuals against your leg to minimize endorotation, then ask the individual to lift their head, that will help to build the muscle tone that is necessary for the training of the muscles to take place. If the individual incapable to come to a sitting position with the unaffected arm and leg. Then it is safe to assume there will be no anchorage created.

It's important to remember that training itself is different to A.D.L. movement. These A.D.L. is based on skills in self-care that also need assistance, but training is pointing on the movement that stimulated individuals to regain skills towards independent sitting. In A.D.L. movement therefore will be the exercise to increase the possibilities in this sitting position. And again this ask for an good cooperation of the whole team, but **Physical therapist** know your responsibility as an exerciser. As once in a sitting position the physical therapist will transfer this patient out of bed because it is often an very heavy exercise. Later one will other members of the care staff can do it. So now we have a new task-specific movement to consider which is extremely important for the individual to develop, which practitioners can assist by support by using task-specific strengthening therapy.

### The technique.

The anchor position needs to be situated on the **lower trunk** so both the pelvis down to the upper leg are involved. The anchor position is required due to the need for the diagonals to have a fixed point, then by lifting the head the muscle tone will increase activating the diagonals and the homolateral structure. Lifting the head also provides an increases muscle tone in the upper trunk on the unaffected side which travels over towards the lower trunk on the affected side. In the lower trunk/leg we see exorotation as a sign that this diagonals are active but sometimes due to the severity of the stroke this may not occur. There may also be an extension or flexion occurring in the affected leg, this is usually due to the upper trunk being more active in the front diagonal (by extension of the leg) or in the back diagonal ( by flexion of the legs) . These reactions are solely due to the need to maintain balance 'balance reactions', which are no so important when considering the individuals ability of movement when coming into a sitting position, but does provide insight into which of the diagonals have the best function.

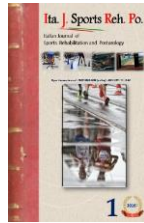
Attention should always focus on the unaffected side, here we will notice sooner the degree of flexion and the extension identifying quicker the movement that the individual seeks. Knowing this helps us to work on activating the other diagonal by creating the anchor on the lower trunk because this movement is part of generating a sideways movement in the lower trunk ( Part 2). Therefore we fixed the lower trunk which activates the other diagonal from the unaffected lower trunk/hip to the affected upper trunk including the homolateral structure on the unaffected side. Now that there is this connection between the upper and lower trunk the individual is able to perform the movements required to come to a sitting position with some assistance.

Two technique which are possible to assist this:

A very difficult technique which enables individuals with lower muscle tone to move

A technique that provides more a facilitate nature of transfer.





**Photo 11.**

**Photo 11.**

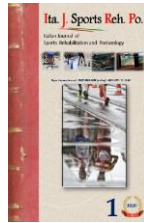
*The physiotherapist has one hand on the upper trunk and shoulder on the affected side and the other hand is completely surrounding both legs. Using his shoulder he push the lower trunk into a sitting position. This provides a possibility to obtain perfect control over the legs although this then requires the physiotherapist to make a further downwards movement with their upper trunk which can increase the load they are supporting making increasing the difficulty.*

*The*

**The Diagonals in photo 11**

The **Blue line** provides support to the diagonal on the unaffected side from shoulder to the spine and when the head is lifted the muscle tone will increase accordingly. But in individuals who have had a severe **stroke this part of the same diagonal that goes over to the affected leg does not have stable base. Although it will still help to stimulate** what is remaining in this area of the diagonals in the lower trunk/hip on the affected side to work. Through the fixation of the upper leg there is **now the potential for reaction in the lower part of the diagonals** which commences in the unaffected leg. **Both blue areas** are therefore capable of shortening the spine and give the remaining areas of the diagonals a fixed point which an now stretch to support and stimulate both front and back diagonals **towards the affected shoulder**. This transfer technique is only use as a starting-exercise to help retrain individuals in the movements required when coming to a sitting position but is not considered part of the A.D.L. movements.

Once progress towards recovery has been made, then we have the opportunity to make a further transfer (see photo 12) which is a A.D.Ls type movement and can also be used in training for physiotherapists to look at increasing the load towards restoring independent function.



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#### Photo 12

*The facilitated technique.*

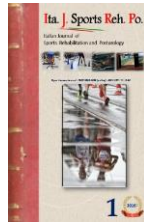
*There is now room for the unaffected arm/hand to be able to push on the bed, although this is usually not enough to get into a sitting position. Therefore the anchor position on the leg is important to encourage the diagonal to work. Remember previously in part 2 of this series, not all pathways from the brain cross over, so this approach is required to activate the affected side as any stimulus from the upper and lower trunk always activate the opposite side to where it is applied. The reason we stimulate this pathway is to provide a sensory experience for the pathways in the brain to receive the required information to start working on a solution to the problem.*

This transfer is now incorporated into the A.D.Ls, initially only when moving out of the bed and not by back into bed, because the returning movement is more difficult and often individuals become fatigued once out of bed whilst recovering.

The physiotherapist can now work specifically on the affected lower trunk and hip. This area needs to be stronger and develop more coordination when looking to restore independent function.

**We can exercise this with individuals lying on their sides, with the movement itself providing the opportunity to start reducing the assistance required from practitioners and to start create a task-specific- strengthening program as the R.M. is less than 100% making increased repetition possible.**

Never underestimate the problems of the affected hip, in the following photo's you can see how in an individual following a stroke, how a bend to the affected side can present (pay particular attention to the movements of the affected leg) (Photos 13 and 14).



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**Photo 13 and 14.**

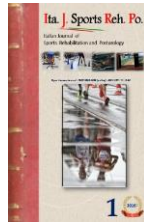
*In photo 13 there is no muscle tone so the patient is support on his affected elbow.*

*In photo 14 the same occurs but now the body is fixed notice how the unaffected leg is flexed against the bench.*

*Notice that in the affected leg there is no exorotation, although there is more endorotation.*

*By moving further towards the affected side the structures in the hip (ligaments) can become stretched so ensure that the movement is performed slowly as there is a risk of rupture to the ligaments if completed too quickly.*

**Photo 13 and 14.**



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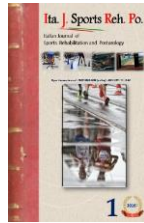
**Photo 15 and 16**

**Photo 15 and 16.**

*In Photo 15 the same fixation with the unaffected leg, but it is more pronounced!*

*In Photo 16 there is no rotation, but there is a lot of extension which means that the individual has activated the front diagonals, although there is a difference between the unaffected and affected sides!*





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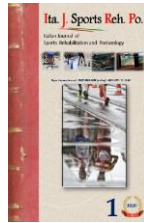
**Photo 17**

**Photo 17.**

*Here we see the difference between the muscle tone of both legs including the coordination of the affected hip . There is too much exorotation which results in hypermobility in the hip joint where the muscle that provide endorotation are too long (See part 3 in the series for more information on this).*

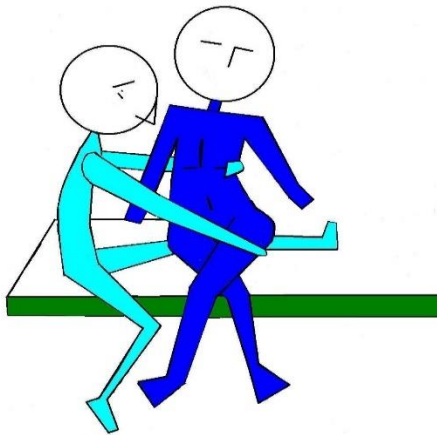
**Endorotation.**

Lying on the edge of the bed on your side ask in the hip on which your laying, when this leg is out of the bed, an active concentric endorotation. And that is only possible as that leg has an exorotation at the starting point. To get an good tone in the under lying leg , often the other leg is in the air. Photo 11 let see that now the burden of that leg and the lift of the upper trunk in the under lying hip an exorotation gives because all diagonal are starting in that hip. Through the endorotation and the push with the arms even the hook with the other leg will give so many points that sitting is easy. But no anchor will make this very difficult. Therefore is training on that part very important.



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#### Picture 11.

*Here is one approach to maintain this position. Whilst sitting on the affected side the individual can lean towards the practitioner so they can help to build up the muscle tone and attitude with the base of the affected hip (Keypoint).*

*Seek to identify a R.M. of 75% then hold that position for 10 sec. Once completed try again but now increase the difficulty by lifting the unaffected leg and continue to hold that position for 10 seconds.*

*Then try to cross the unaffected leg over the affected leg without grasping with the unaffected hand for stability.*

*Further increase by giving resistance against the trunk and the lifting leg.*

**This is also an extremely useful exercise to help develop the individuals balance when sitting!**

**Part 4 ended her and part 5 goes on with the transfer from sit back to bed.**

## Appendix

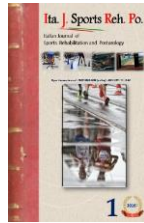
### Chain rules.

Normally we use these “chain rules” automatically to generate more power when lifting something such as a heavy suitcase, where without having to think about it, we use our other arm as support a surface such as a table to complete the lift. For individuals undergoing rehabilitation following a stroke it is therefore important to consider these chain rules to provide more muscle reaction which helps to generate a lower level stimulus for the brain which provides the needed information for the damaged brain to start the process of recovery. The diagonal are the most important part in building a sequence of moves as part of these chains. There are 4 steps in moving from a closed to an open chain.

### Closed Chain.

This is where there is no movement and the body is supported with 4 points, which involves the actions of 6 muscle patterns.





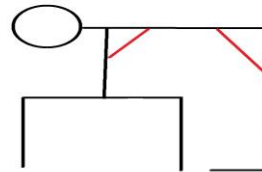
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#### Photo 18.

*Support with both arms on the crutch provides the most stable form when training. From this position we can move over a surface both forwards or backwards, and we can look at lifting the stool. Practitioners need to recognize this is a difficult movement (R.M.) so look to creating an exercise that provides the potential to train both coordination and power. For individuals who have had a stroke maintaining this position can be very difficult without applying movement thus this is one of the first exercises to do in the sequence.*



In the next picture the red lines are the most important anchors that are required to maintain this position. Look at the photo where the extension of the right elbow is also difficult. The individual is having a problem holding the extension and they are incapable of doing this together with the adductor of the arm - m.pectoralis.

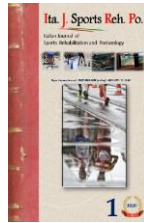
#### **The muscle pattern which are active here are:**

1. Muscle patterns between the legs (adductor)
2. Between the arms (adductor)
3. Between the left leg and the left arm
4. Between the right arm and right leg

This also includes the diagonals:

5. Between the left arm and right leg
6. Between the right arm and left leg

When building this position using a support , it is necessary to inhibited the flexor synergy of muscle tone, whilst strengthening the extensors of the arm as much as possible. When the affected arm is carrying a weight the 6 muscle pattern are active enabling the muscles to perform. Holding this attitude for several minutes can result in an exercise which has a 100%



R.M. so it is important to start small and look at increasing the time slowly. After this has been established then you can look to moving a leg which will change the 6 muscle pattern into 3 when as the leg lifts from the surface of the floor.

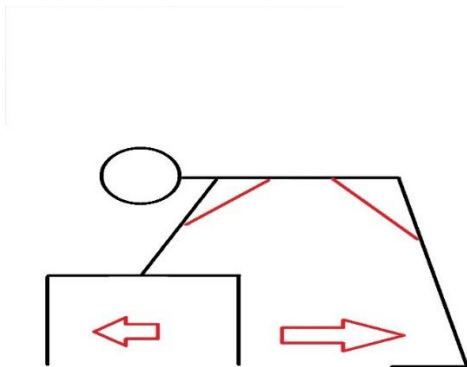
### Which leg should be lifted?

In this situation the front diagonals are dominant when you lift the unaffected leg (individual on photo 18) and will collapsed the whole closed chain system. Therefore because the diagonals in the unaffected arm over to the affected leg are not as strong, whilst at the same time the affected arm may have difficulty in holding on to something without the support of the remaining parts of the front diagonals. Conversely lifting the unaffected leg is an activity for the back diagonals and this can result in flexor synergy in the affected arm.

So overall a more appropriate next step would be to use the dynamic closed chain.

### 2. Dynamic closed chain.

In Photo 18 the individual is trying to slide the support forwards slightly and then lean on it. Or pull it backwards. Later on movement with the legs is possible but make it slide movements.



#### Picture 12.

*Here we have 6 muscle pattern intact but there needs to be more selectivity to enable the support stool to be moved across the floor. There needs to be a shifting of the weight with the front diagonal working (eccentric) allowing the support stool to be pushed. This activity in this position uses the back diagonals.*

When holding 4 points with movement requires the activity of the homolateral structure to be less important, but for example when we slide using just one hand (which is common for individual who have had a stroke) then due to not having any more than the original 6 muscle pattern, the homolateral structure become more important and control is difficult. The best passage from no movement is by sliding movement and first movement with arm /upper trunk and after that the legs. That gives the therapist also an extra dimension by asking it together or without gliding or with resistance R.M. 60-70%.



**Photo 19**

*An individual with a left side affected following a stroke. Notice how they push the chair forwards with the unaffected arm. The pushing movement stimulates the swing phase of the affected leg (front diagonal) but also the standing phase when support is taken by the chair when placing the unaffected leg forwards (back diagonal) Look at the high flexor synergy tone in the arm, this requires a greater effort, and is also due to the increased work from the unaffected leg.*

Here we have a dynamic closed chain but with only 3 muscle patterns When the individual stands on both legs.

1. Between both legs
2. Between the right arm and right (unaffected) leg.
3. Between the right arm and the left (affected) leg.

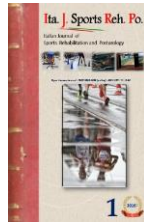
In photo 19 we see that the individual walks without stopping which requires the chair to move whilst lifting the affected leg which has only one dynamic closed chain from the unaffected arm to the unaffected leg. Here the homolateral structure on the unaffected side needs to work very hard. When the individual stands on the affected leg he only has one dynamic closed chain which is the diagonal from the right arm to the left leg. At this point the angle of the back diagonal in the lower trunk is less than 45 degree, additionally the diagonal agonist (back) antagonist (front) will need to go through the adductors of the leg and because there is too much flexion in the hips, and all the adductors are positioned behind the hip joint which will act as extensor/adductor.

Adduction is any part of the extension synergy of the leg therefore will be increases.

Although this is not a major problem, it can lead to a loss of selectivity in the leg.

### **3. Dynamic Half closed chain.**

Closed refers to the support gained from the support, while dynamic refers to the movement across that surface. A half-closed chain identifies when there is no support on the floor but dynamic gives on that there is well an support but not on the surface but over the surface. This suggests the need for more understanding of where does the border of one meet with the



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other. Overall this is not so important, as we know there is a border, and that there is little room between moving from one side to the other, but it also means there are plenty of possibilities to develop exercises which vary and look at working on developing coordination and power. A perfect example of this is in picture 13. When holding something using both hands and then move it across a surface.

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**Figure 13.**

*The problem is maintaining enough power in both hands but not in excess causing the fingers to flex. Trying to move the object further away requires an 'extension' which is part of the extension synergy where the arms can go into endorotation. Moving the object closer to the chest is a flexion synergy and now the arm move to an exorotation. By using a 'towel' this movement is now possible, and the direction can be varied.*

A 'dough roller' is a dynamic closed chain, where in comparison walking with a rollator frame is more a dynamic half closed chain for the individual in photo 19. Therefore this is a dynamic half closed chain! For the same individual about a year later!!





**Photo 20.**

*It appears not to be a half closed chain but the rollator frame has two wheels at the front which can rotate in all directions. That is a significant difference to the chair and that's why this is a half closed rather than closed chain. The individual can support a little but the rest requires correction to maintain balance and coordination. Observe how standing on the affected leg creates a closed chain pattern if the right arm to the right leg where he is capable of holding the rollator frame still, but when the frame is actually moving this changes to become dynamic and half closed.*

*Closed will require no homolateral activity while half closed will require support from these structures. This is the reason why patient stand still initially.*

Dynamic Half closed chain provide the individual with more control which is often the highest level of performance achieved with individuals who have had a stroke especially for the affected arm. Therefore it is so important that we seek for solutions that makes is possible for the individual to benefit from the exercises in developing their A.D.Ls skills and movement.

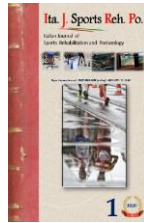
One example of this is an individual who does not have good balance skills sufficient to be able to put a coat on independently.

Here we see two issues,

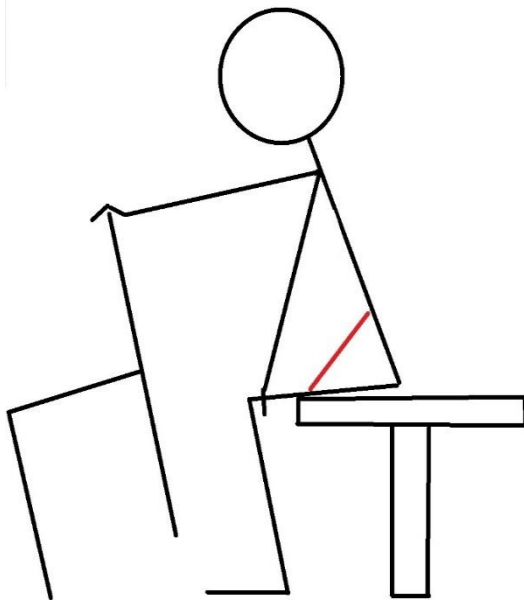
1. Not enough extension in the elbow and
2. Maintaining balance.

The first exercise focuses on creating an extension in the elbow with more power developed in the front diagonal from the affected arm to the unaffected leg. This helps to develop more extension and protraction in the front of the body (See picture 14). We use a chair, which at the start was more than 100% R.M. but as the skills developed the individual was able to move up the chair with heavy resistance and in different angles.

This capacity was used to create a greater support area when the individual was standing and trying to get the coat over his affected arm (See photo 21 for more detail).



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**Picture 14.**

*Starting position.*

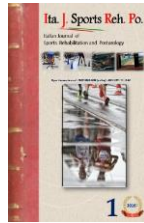
*The purpose of the exercise is to hold the chair on two legs. This requires an extension in the elbow, and a protraction in the shoulder which evokes a reaction in the front diagonal from the affected side to the unaffected side. Observing the individual you will notice that this is a closed chain, although due to the front diagonal being involved which has its base on the unaffected side, a further closed chain has been created by placing the unaffected arm on the unaffected leg. This exercise often requires more than 100% R.M. so the individual should start by holding for as long as possible. When this can be maintained, we then start looking at them to lower the chair without the back legs touching the ground, we can then start considering working by applying load.*

Repetition by variation. Now we change the direction more to the opposite side or more sideways until the chair stand on its side, again with movement and load. Following this we try and change the closed chain to a dynamic half closed chain by asking the individual to place the chair on one leg and change from one leg to another etc.

Or we give resistance and make it an task specific resistance training by putting sandbags on the chair sit part and make it difficult to hold the chair in that position.

But the movement of the chair ask also for an eccentric and concentric action in the affected arm and then is the closed chain on the unaffected side the anchor for the other chain to work optimal.





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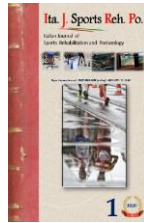
#### **Photo 21.**

Using this increases the ability of the shoulder and elbow to create a solution for the individual to put his own coat on. The support against the wall helps to control balance.

The individual flexes his elbow and places the sleeve over the affected arm, then pushes with the elbow and shoulder into the wall so they can bring the sleeve over the elbow up to the shoulder and all away round to the back. Now they bend the upper trunk to the front and stretches the affected arm whilst remaining supported against the wall. This provides greater anteflexion in the arm. Due to the better support area, the coat is less likely to fall from the affected shoulder and now they are capable of reaching the coat with his other hand completing the task.

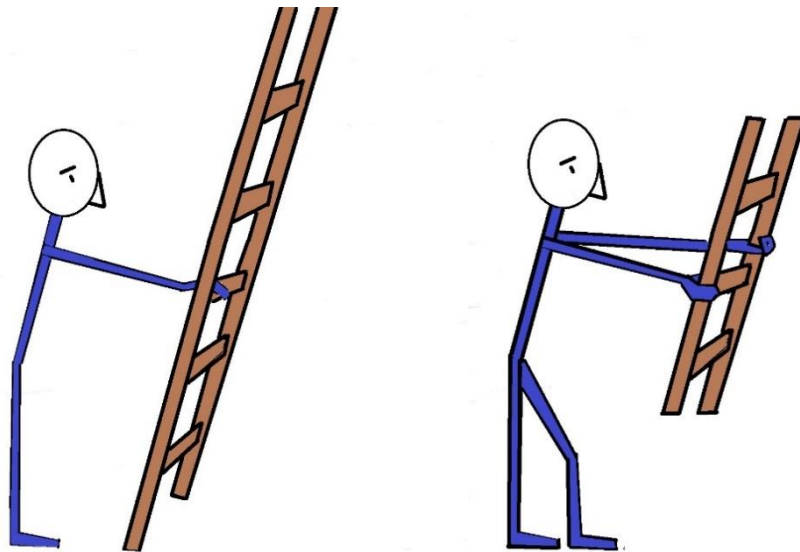
A dynamic half closed chain requires less selectivity but the exercise remains heavy and at times heavier than a half closed chain.

Example: Exercise with an ladder

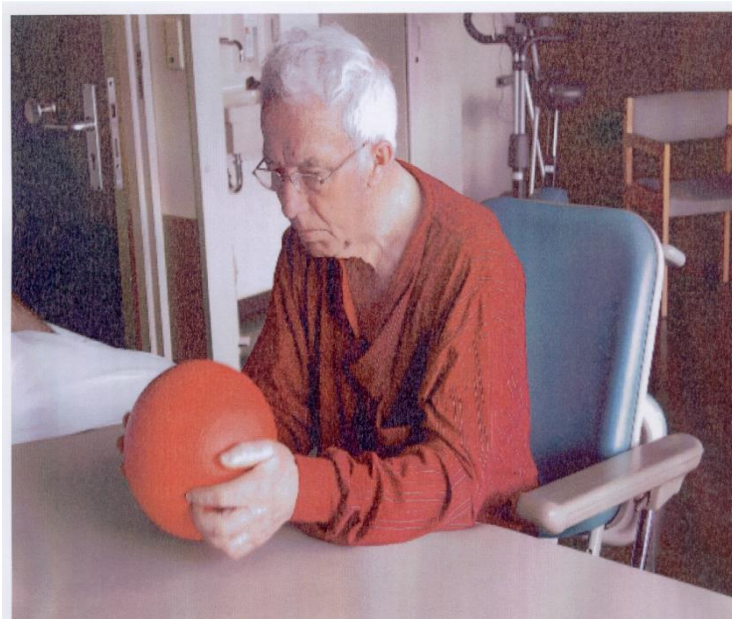


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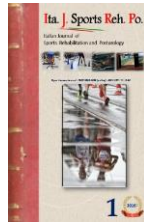


**Picture 15:** Trying to walk the ladder from one leg to the other. This is a dynamic half closed chain but with using only one hand and arm this exercise can be very difficult and extremely heavy.  
**Picture 16:** Lifting a ladder with both hands and arms, this is now a half closed chain but the difficulty and weight load is reduced.



**Photo 23**  
 Provides an example of a half closed chain for both hands but due to the elbows being supported on the table there is now a closed chain which an easier degree of control over the hands.

**Photo 23**



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### Half-closed chain.

Here the load between two hands must be completely off the surface. In figure 16 and photo 23 there is a significant difference in the heaviness of the exercise. Although it requires no more selectivity, just muscle power. The same can be said for photo 24 although when we ask for the stool to be lifted and placed on top of the head, it is not only heavier it is also more difficult to achieve!

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**Photo 24.**

### Photo 24.

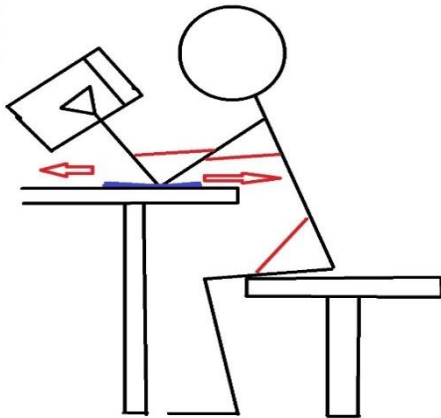
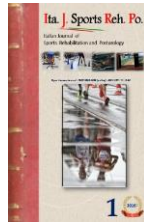
*The first part to achieve is to hold the stool. The individual must make an extension and endorotation with the arms. But due to lifting the stool up this requires a flexion synergy with exorotation.*

### **We now have all the learning rules,**

1. This task-specific exercise of carrying something with two hands,
2. It demands the same muscles and
3. The same sensomotor pathway.
4. It requires more energy.
5. The goal is obvious.

*This exercise has a 100% R.M. and the individual can hold the stool for only 1 minute at the start, but after three months, progress has been made towards increasing the load and movement towards reach the head and being able to carry other objects.*

By using chains we can develop so many exercises through variation. Picture 17 demonstrates this quite well!



**Picture 17.**

*(An artistic impression of photo 23) Sitting with bent elbows whilst a ball or tin can in the hands. This is a half-closed chain with support, which means that the diagonals are controlled by a closed chain. The joints that are free are the wrist and the fingers. Lifting the arms off the surface of the table creates a total half-closed chain but that increases the level of difficulty to maintain. Lifting is a flexor synergy, which produces abduction and exorotation, where we need adduction of the upper arm. Lifting and stretching the arms provides extension and adduction (extension synergy) but also endorotation and this affects the hands ability to maintain hold on the ball or tin can.*

**Picture 17.**

What we can change is the support we get from the table. If we place a towel under the elbows then we can ask the individual to move over the towel forwards, backwards, sideways or even drawn a circle or picture whilst holding the object. Think on the 5 trainings rules and you can use load to stimulate the coordination and the power of the muscles.

### Open chain

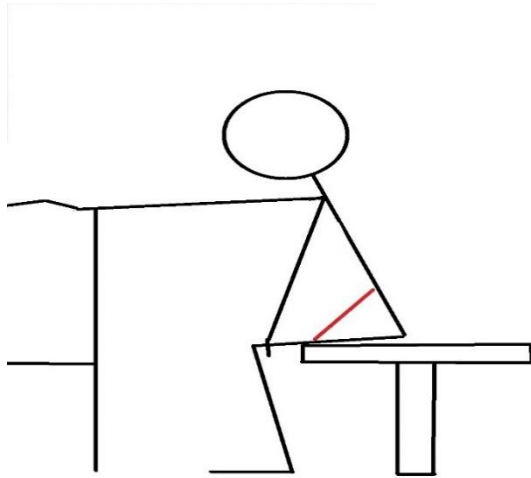
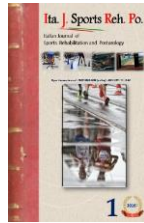
This is the most difficult movement there is. Without support the individual is required to make a movement coming to the right spot at the right time. This requires the central nervous system to function in supporting the arm and hand movements which after a stroke may well be unattainable, reducing the potential for achievement.

There are predicted rules that state *“Only when there are arbitrary abduction in the shoulder and arbitrary extension of the fingers and wrist 72 hours following a stroke then this movement may be possible. When they are not present, it is most unlikely the individual will ever recovery fully”* ( Prof.G.Kwakkel and others). Even so this provides, the Physiotherapist must work with a goal for the individual to get as close as possible to achieving this level of recovery and to try achieving as much use for the individual as possible. Therefore when working in an open chain this can often be much too difficult an exercises to do independently therefore consider using different chains is very important along with trying to make a transition between training and A.D.Ls. That affords the individual the best opportunity to recover use of the affected arm and hand. Movements with the hand open and closed can improve training with the arm supported in a closed chain.

Often it is possible to created enough closed chains or half closed chains (dynamic when necessary) to at least get a part of the arm, for example the fingers or both fingers and wrist to move in an open chain.

This can also be built into an exercise, whilst always searching for a way of practicing using A.D.Ls.



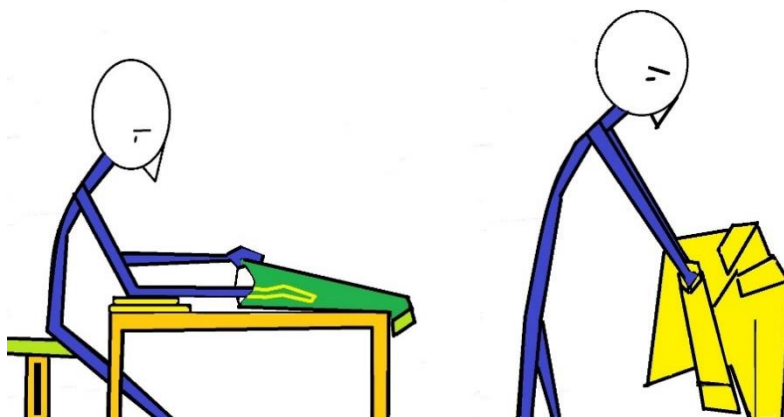


**Picture 18.**

Exercises to obtain arbitrary control over the extension of the fingers. The arm rests on the back a chair then get the individual to make a pushing movement. It is easier to get extension movement in the wrist and fingers through this movement with practice. The activity provides an action in the upper part of the front diagonal on the affected side, creating protraction in the shoulder, extension of the elbow which in turns allows for mass extension of the fingers!

**Picture 18.**

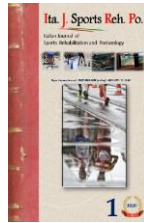
In combination with pushing the upper body forwards (a movement of the upper trunk creates a flexion rotation of the upper part of the front diagonal). The individual can use this ability to stretch their arm and fingers into the sleeve of a sweater. Sometimes it is possible to have extension in the arm and hand by using an open chain to start putting a coat or sweater on (see photo 21).



**Picture 19 and 20.**

**Picture 19 and 20:**

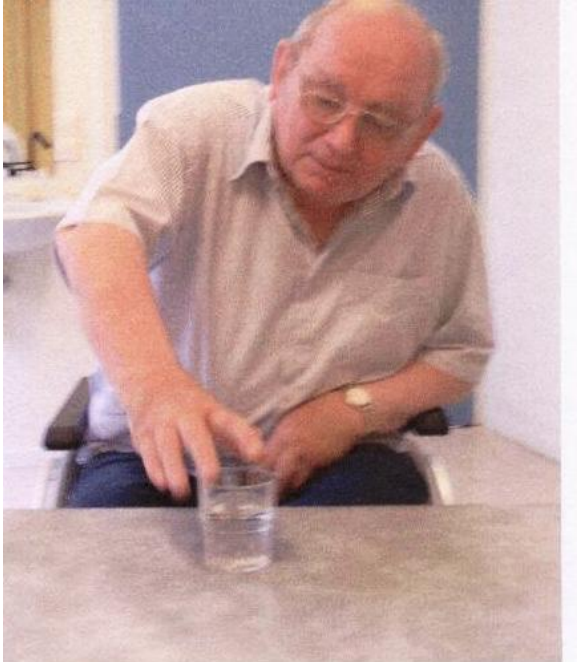
*Both of these movements require the individual to maintain their hand and elbow in one position, then the movement will completed using the shoulder and the upper trunk. The Upper part of the front diagonal together with the distal part can produce a flexion rotation of the upper trunk enabling the specific movements necessary to place the arm in the sleeve. Now the arm a part to play in developing the A.D.Ls skills which are so important !!*



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Here is an example of a combination of chains that make it possible to do things independently. The chain is almost but not quite open. This is very similar to when we look towards normal motoric actions.



**Photo 26.**

*This individual has a paretic left side. They are reaching to pick up the glass, but the flexor synergy is bracing the movement. Therefore we see abduction and exorotation(flexor synergy) in the shoulder, the extension and supination are not possible, but the finger extensions are. Observe the closed chain on the unaffected side to stabilize the diagonals, although it is not enough to fully control the back diagonal on the affected side.*

**Photo 26.**

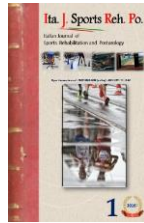
Now the individual has the glass but cannot drink. When they use a dynamic half closed chain, as within this example, the 'hand master' (Ness) was active, they were able to glide over the surface of the table, to grasp the glass, then with assistance from the other hand (a half closed chain) able to take a drink.

Hand master (Alon)



**Part 10,** will go about the possibilities to train an arm/hand after stroke.

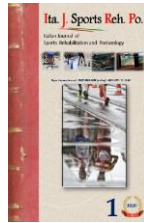




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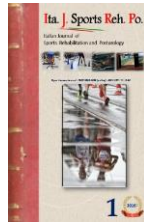
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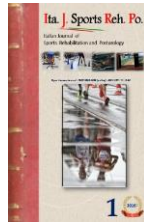
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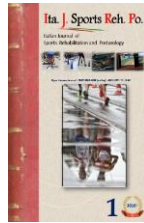
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